ACCESSION #: 9707160180
LICENSEE EVENT REPORT (LER)

FACILITY NAME: COMANCHE PEAK STEAM ELECTRIC STATION
UNIT 1 PAGE: 1 OF 10

DOCKET NUMBER: 05000445

TITLE: LOSS OF MAIN FEEDWATER FLOW DUE TO FEEDWATER ISOLATION
VALVES CLOSING RESULTED IN A MANUAL REACTOR TRIP
EVENT DATE: 01/22/96 LER #: 96-002-01 REPORT DATE: 07/10/97

OTHER FACILITIES INVOLVED: CPSES UNIT 2 DOCKET NO: 05000446

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:
50.73(a)(2)(i)
50.73(a)(2)(iv)

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COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On January 22, 1996, at approximately 8:00 a.m. (CST) during troubleshooting on safety-related inverter IV1EC1, power was lost to panel 1EC1 which caused the four Main Feedwater Isolation Valves (MFIVs) to close. Closure of the MFIVs caused a loss of main feedwater flow which resulted in a manual reactor trip. The event was caused by a less than adequate initial troubleshooting plan following a malfunction on inverter IV1EC1. Operations procedures have been revised to clearly note when the inverter transfer switch is to be placed in the bypass position. During the closure of the MFIVs, it was noted that MFIV 2 was slow to close. Further investigation revealed that this MFIV could have been inoperable for a period of time longer than allowed by Technical Specifications (TS). MFIV 2 was potentially inoperable due to foreign material in the hydraulic solenoid valve. The solenoid valves in the

potentially inoperable MFIV were replaced and the MFIV was successfully tested.

END OF ABSTRACT

I. DESCRIPTION OF THE REPORTABLE EVENT

A. REPORTABLE EVENT CLASSIFICATION

Any event or condition that resulted in a manual or automatic actuation of an Engineered Safety Feature (ESF) including the Reactor Protection System (RPS)(EIIS:(JC)). Main Feedwater Isolation Valve (MFIV) 2 (EIIS:(ISV)(SJ)) could have been inoperable for a period of time which exceeds Technical Specifications (TS) and this condition is reportable as a condition prohibited by TS.

B. PLANT OPERATING CONDITIONS PRIOR TO THE EVENT

On January 22, 1996, Comanche Peak Steam Electric Station (CPSES) Unit 1 was in Mode 1, Power Operation, and operating at 100 percent power.

C. STATUS OF STRUCTURES, SYSTEMS, OR COMPONENTS THAT WERE INOPERABLE AT THE START OF THE EVENT AND THAT CONTRIBUTED TO THE EVENT

Inverter IV1EC1 was inoperable at the start of the event and contributed to the event. MFIV 2 closed within approximately 38 seconds which exceeded the TS criteria (5 seconds).

D. NARRATIVE SUMMARY OF THE EVENT, INCLUDING DATES AND APPROXIMATE TIMES

On January 22, 1996, at approximately 4:20 a.m. (CST) Operations personnel (utility,licensed) in the control room received a Safety System Inoperable Indication (SSII) train 'A' 118VAC alarm. Upon investigation, it was determined that inverter IV1EC1 (EIIS:(INVT)(EF)) had reverse transferred to the unregulated AC supply via the static switch (automatic). Operations and Maintenance personnel (utility, nonlicensed) commenced troubleshooting on inverter IV1EC1 and determined that the fuse (EIIS:(FU)(EF)) had blown on the DC to DC converter card. The Shift Manager (utility, licensed) notified the System Engineer (utility, non-licenced) and the method of replacing the blown fuse was discussed by the Shift Manager, System Engineer, and the Operations and Maintenance personnel who were involved in the initial troubleshooting on inverter IV1EC1. The personnel involved decided that the fuse would be

replaced with the inverter transfer switch (manual) in the static switch position. When the attempt was made to replace the blown fuse, the static switch (automatic) (EIIS:(IS)(EF)) transferred back to the failed inverter, and power was subsequently lost to panel 1EC1 (EIIS:(BU)(EF)). The loss of power to panel 1EC1 resulted in the closure of all four MFIVs and at approximately 8:06 a.m. (CST) operators manually tripped the reactor due to the loss of feedwater flow. Operations restored power to panel 1EC1 and stabilized the plant in Mode 3 in accordance with operating procedures.

During the event, MFIV 2 took approximately 38 seconds to close after the loss of power to panel 1EC1. Upon disassembly of the hydraulic solenoid valve for MFIV 2, a small metal fragment was discovered in the valve between the fluid filter screens. The repositioning of a hydraulic solenoid valve allows hydraulic fluid to bleed off allowing the MFIV to close. The fragment found was of sufficient size to cause decreased hydraulic fluid flow which in turn caused a slower valve opening time. Engineering personnel (utility, non-licensed) determined on February 8, 1996 that MFIV 2 could have been inoperable for a period of time which exceeded TS. TU Electric believes that the dual train test, which is performed more frequently than the single train test, may have masked this potential problem with a single train's solenoid valve.

E. THE METHOD OF DISCOVERY OF EACH COMPONENT OR SYSTEM FAILURE OR
PROCEDURAL ERROR

On January 22, 1996, at approximately 4:20 a.m. (CST) Operations personnel (utility, licensed) received an SSII train 'A' 118VAC alarm.

On February 8, 1996, at approximately 8:00 a.m. (CST) Engineering personnel (utility, non-licensed) discovered that MFIV 2 could have been inoperable for a period of time which exceeds TS.

II. COMPONENT OR SYSTEM FAILURES

A. FAILURE MODE, MECHANISM, AND EFFECT OF EACH FAILED COMPONENT

The DC to DC converter input fuse was blown in inverter IV1EC1. The DC to DC converter is the regulated power supply for the inverter control circuitry and the front panel indicator lamp circuitry. Through an auctioneering circuit, the converter will also supply back-up power to the static switch control circuitry normally fed by a bypass voltage generated unregulated power supply.

During subsequent troubleshooting on the inverter, the static switch (automatic) control circuitry for the inverter did not operate properly. The static switch (automatic) functions to transfer the load current to the bypass power source (reverse transfer mode) or to the inverter power source (forward transfer mode). During the troubleshooting efforts, the static switch (automatic) malfunctioned by transferring the load back to the inverter, which had no output.

After MFIV 2 was noted to be slow in closing on January 22, 1996, the train 'A' hydraulic solenoid valve was disassembled and a small metallic fragment was found between the fluid filter screens in the valve body. Subsequent evaluations by Engineering determined that the fragment could restrict fluid flow such the valve could close more slowly than the TS criteria (5 seconds).

B. CAUSE OF EACH COMPONENT OR SYSTEM FAILURE

TU Electric believes that the DC to DC converter input fuse was most likely blown due to the degradation of the C113 and C114 capacitors. TU Electric believes that the static switch (automatic) malfunctioned due to a voltage transient of unknown amplitude which was presented to the static switch (automatic) control circuitry. This transient was most likely caused by a small spark which was created as the large C113 and C114 capacitors charged when the replacement fuse was installed. The J4 and J5 static switch cards had unstable logic voltage which contributed to the static switch (automatic) malfunction.

TU Electric believes that the cause of MFIV 2 being potentially inoperable for a period of time which exceeds TS was most likely due to foreign material in the hydraulic solenoid valve. Although the fragment in the hydraulic solenoid valve was the primary cause of the slow closure of MFIV 2, TU Electric believes that the nitrogen solenoid valves on MFIV 2 had possibly degraded and also contributed, to a lesser extent, to the slow closure of the valve.

C. SYSTEMS OR SECONDARY FUNCTIONS THAT WERE AFFECTED BY FAILURE OF
COMPONENTS WITH MULTIPLE FUNCTIONS

Not applicable - No failures of components with multiple functions have been identified.

D. FAILED COMPONENT INFORMATION

Elgar Corp.
Model Number UPS 103-1-132
118VAC Safeguards BOP Inverter

Borg Warner
Model Number 38878-1
Hydraulic Solenoid Valve

III. ANALYSIS OF THE EVENT

A. SAFETY SYSTEM RESPONSES THAT OCCURRED

The Reactor Protection System (EIIS:(JC)) and Auxiliary Feedwater System (EIIS:(BA)) actuated during the event.

The Motor Driven Auxiliary Feedwater (MDAFW) pumps (EIIS:(P)(BA)) and the Turbine Driven Auxiliary Feedwater (TDAFW) pump (EIIS:(P)(BA)) automatically started as designed on Lo-Lo Steam Generator (SG)(EIIS:(SG)(SB)) water level. During the event, all SG levels dropped low in the wide range due to the loss of normal feedwater prior to the trip and the continued steam relief to the main condenser

(EIIS:(COND)(SD)) through the main feedwater pump turbines and, initially, the Steam dump valves (EIIS:(RV)(SB)). Pressurizer (EIIS:(PZR)(AB)) level and Reactor Coolant System (RCS)(EIIS:(AB)) pressure dropped due to the cooldown caused by the loss of control power from panel 1EC1 to the MDAFW flow control valves to SGs 1 and 2 and TDAFW flow control valves to SGs 3 and 4, AFW flow, and excessive steam relief.

B. DURATION OF SAFETY SYSTEM TRAIN INOPERABILITY

Inverter IV1EC1 was inoperable from January 22, 1996, to January 29, 1996.

Although it cannot be determined conclusively, TU Electric believes that the metal fragment may have been in the valve when this hydraulic solenoid valve for MFIV 2 was installed in November, 1993. Therefore, MFIV 2 is conservatively considered to have been inoperable from November, 1993 until the solenoid valves were replaced on January 24, 1996.

C. SAFETY CONSEQUENCES AND IMPLICATIONS OF THE EVENT

1. Slow MFIV Closure Time

The MFIVs are credited in the accident analysis to limit the amount of feedwater flow into the steam generators in order to:

a. reduce the inventory released in the event of a secondary system pipe break;
b. limit the cooldown of the RCS due to a secondary system pipe break;
c. limit the steam generator inventory in the event of a steam generator tube rupture; and, d. protect the main turbine from excessive moisture due to high steam generator water levels.

In the accident analysis, the primary concern is the completion of the feedwater isolation function. The feedwater isolation function is accomplished, even with an assumed single failure, by

the redundant closures of the main feedwater isolation and associated bypass valves and the feedwater flow control (feed reg valves) and associated bypass valves. The feedwater control and bypass valves receive the same feedwater isolation signals as the feedwater isolation valves. The feedwater control and bypass valves were operating properly throughout the time period when the MFIV may not have been operable; thus, even if the MFIV was closing slower than required, the feedwater isolation function was completed in a timely manner. Thus, the potential effects of a slow-responding feedwater isolation valve would not have affected the safety and health of the public.

2. Loss of Normal Feedwater Flow

The event of January 22, 1996 was similar to the loss of normal feedwater event analysis presented in FSAR Section 15.1.7. The loss of normal feedwater is classified as ANS Condition II event and is analyzed to demonstrate the adequacy of the decay heat removal capabilities of the Auxiliary Feedwater and Reactor Coolant Systems. The relevant event acceptance criterion is that the loss of normal feedwater event shall not lead to a more serious event; i.e., an ANS Condition III or IV event. This requirement is satisfied by demonstrating that the pressurizer does not completely fill with liquid prior to the time that the decay heat load has fallen to be within the heat removal capacity of the Auxiliary Feedwater and Reactor Coolant Systems.

Differences between the event of January 22, 1996 and the event analyzed in FSAR Section 15.2.7 include:

a. The Steam Dump System is not credited in the analysis. This system acts to prevent an excessive increase in the RCS temperatures.

b. The main feedwater pumps are assumed to be tripped in the analysis. The use of this assumption precludes any steam relief through the main feedwater pump turbines.

The effects of these differences are to minimize the amount of steam which can be released, thereby reducing the capability of the secondary system to remove heat from the Reactor Coolant System. Therefore, the assumptions related to heat removal used in the FSAR Section 15.2.7 analysis are more limiting than the January 22, 1996 event.

Based on the above comparison, the event of January 22, 1996, is bounded by the analysis of the loss of feedwater event presented in FSAR Section 15.2.7. Therefore, it is concluded that the health and safety of the public were unaffected by this event.

IV. CAUSE OF THE EVENT

TU Electric believes that the cause of the event was a less than adequate initial troubleshooting plan following a malfunction on inverter IV1EC1. Prior to the replacement of the blown fuse, the personnel involved reviewed the vendor technical manual, applicable drawings, and applicable procedures related to the troubleshooting of the inverter. Based on review of these documents, it was not clear if the inverter transfer switch (manual) should be placed in the bypass position or the static switch position in order to change the blown fuse. After discussing the proper positioning of the switch, the personnel involved decided to replace the fuse with the transfer switch (manual) in the static switch position. This technique had been used successfully in the past for work on inverters and the inverter was not expected to enter the forward transfer mode during the fuse change out. However, when the fuse replacement was attempted, the static switch (automatic) malfunctioned, the inverter forward transferred, and the load current was interrupted. If the transfer switch (manual) had been placed in the bypass position during the fuse replacement, the load current would most likely not have been lost. TU Electric believes that the cause of the event was inadequate troubleshooting methods due to the personnel involved choosing a less conservative method for replacing the fuse, when a more conservative method (putting the manual transfer switch in the bypass position) was available.

TU Electric believes that the cause of MFIV 2 being potentially inoperable for a period of time which exceeds TS was most likely due to foreign material in

the hydraulic solenoid valve. Although the fragment in the hydraulic solenoid valve was the primary cause of the slow closure of MFIV 2, TU Electric believes that the nitrogen solenoid valves on

MFIV 2 had possibly degraded and also contributed, to a lesser extent, to the slow closure of the valve. During the 1993 Unit 1 refueling outage, all solenoid valves were replaced on MFIV 2. After MFIV 2 was noted to be slow in closing on January 22, 1996, the train 'A' hydraulic solenoid valve was disassembled and a small metallic fragment was found between the fluid filter screens in the valve body. Subsequent evaluations by Engineering determined that the fragment could restrict fluid flow such the valve could close more slowly than the TS criteria (5 seconds).

V. CORRECTIVE ACTIONS

TU Electric's initial corrective actions included repair of the identified inverter deficiencies and successful functional testing of inverter IV1EC1. Operations procedures have been revised to clearly note when the inverter transfer switch is to be placed in the bypass position. Although TU Electric believes that the failure of inverter IV1EC1 was an isolated occurance, extensive actions have been taken to improve the performance of the Unit I Elgar inverters including 1) functional testing of the inverters, 2) replacement of selected capacitors, relays, fuses on all 10KVA inverters, 3) calibration of meters, 4) detailed visual inspection of all inverters including the identification of obvious damaged components, missing and loose components, and thermoscan evaluations.

The above corrective actions will also be implemented for the Unit 2 Elgar inverters during the upcoming refueling outage for Unit 2.

For the Westinghouse inverters (refer to LER 445/96-001), TU Electric has also taken extensive actions to assure the reliability of the Unit 1 Westinghouse inverters including 1) replacement of selected capacitors in all Westinghouse inverters, 2) replacement of selected circuit boards in all Westinghouse inverters, 3) detailed visual inspection of all Westinghouse inverters including the identification of obvious damaged components, missing and loose components, and thermoscan evaluations, 4) functional testing of all Westinghouse inverters, and 5) calibration of meters.

The above corrective actions will also be implemented for the Unit 2 Westinghouse inverters during the upcoming refueling outage on Unit 2.

In addition to these actions, a program for long term modifications/

improvements for both the Westinghouse and Elgar inverters is also being developed and these modifications/improvements, when implemented, will provide additional assurance of the reliability of CPSES inverters.

The hydraulic and nitrogen solenoid valves were replaced on MFIV 2 and the MFIV was successfully tested for closure time by individually testing each train. TU Electric will evaluate the periodicity and methodology related to the testing of the MFIVs in order to assure reliability of the valves.

VI. PREVIOUS SIMILAR EVENTS

There have been previous similar events that resulted in an RPS actuation related to an inverter failure. However, corrective actions taken to resolve the causes of the previous events would not have prevented this event.

There have also been previous events related to slow closure of MFIVs on both units. However, the previous slow closures of the valves were reviewed during the disposition of this event; and no previous events that had the same root cause, or the same failure, or the same sequence of events were found.

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